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STATE OF ALASKA

Jay S. Hammond, Governor

Annual Performance Report for

A LIFE HISTORY STUDY OF SHEEFISH AND WHITEFISH IN ALASKA

by

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RESEARCH PROJECT SEGMENT

State: Alaska

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Project No.: F-9-7

Study Title: A LIFE HISTORY STUDY OF SHEEFISH AND WHITEFISH IN ALASKA.

Study No.: R-II

Period Covered: July 1, 1974 to June 30, 1975.

ABSTRACT

Eggs taken from sheefish, Stenodus leucichthys, in the Koyukuk River at Hughes and in the Yukon River at Rampart suffered 100% mortality. Unripe condition of fish is suggested as the major cause of mortality. Small numbers of sheefish have been recovered in Lost Lake from a 1973 plant of 44,000 fry. Test netting in Four Mile Lake resulted in a catch of 13 fish (2 net nights) in May and 8 fish (2 net nights) in December. Of the fish caught in May, those of 1968 plant averaged 589 mm and 2.27 kg while two fish of the 1969 plant averaged 533 mm. The December caught fish (all part of the 1968 plant) averaged 580 mm and 2.42 kg.

During a three year study on sheefish of the middle Yukon River, 1,890 fish were captured, of which 1,257 were tagged and 83 recovered. Fish tagged in the lower Yukon River in 1974 were recovered both on the upper Koyukuk River spawning ground and in the Rampart area, indicating that fish wintering in the lower Yukon River and those spawning on the upper Koyukuk River and upstream of Rampart constitute a single population. Sheefish in tributary streams of the Nowitna, Ray, and Dall rivers and Hess Creek probably belong to this population. Porcupine River sheefish comprise another population.

Radio transmitters placed on sheefish in the Yukon River near Rampart to determine spawning movements were partially successful and resulted in one tagged fish being followed for 50 km upstream from the release site. Large numbers of sheefish in spawning condition migrating past a netting site 29 km above Rampart as late as October 4 were believed to spawn in the main Yukon River in the vicinity of the Yukon Flats.

Arctic lampreys, *Lampetra japonica*, whitefish, mainly *Coregonus sardinella*, and *C. pidschian*, and suckers, *Catostomus catostomus*, are the main summer food items for middle Yukon River sheefish.

The main utilization of sheefish in the middle Yukon River at present is for subsistence, but fish found in the mouths of clearwater tributary streams from Ruby to Ft. Yukon are utilized by sport fishermen during the summer.

RECOMMENDATIONS

It is recommended that:

1. Egg takes use only females with free running eggs.

2. Bearpaw River (Kantishna River System) be investigated as a new egg take source.

3. The search for sheefish spawning grounds in the middle Yukon River concentrate in the Yukon Flats between Stevens Village and Ft. Yukon.

4. Additional studies under this project include fishery resource investigations on the lower Kuskokwim River systems.

BACKGROUND

The sheefish lake and river adaptability study deals with perfecting methods of taking eggs, hatching them, and rearing the young, as well as locating new waters for experimental transplants and following success of previous plants. In the past two years of the study eggs have experienced 100% mortality at the hatchery. It was thought that improper techniques of taking eggs and delay in getting them to the hatchery were responsible. Future work will be directed toward solving these problems. Preliminary work has been completed on installing a water cooling system in the Fire Lake Hatchery at Anchorage to retard hatching time. Rearing ponds are available at Clear Air Force Base for raising sheefish fry to fingerling size, but other types of rearing ponds and lakes will be investigated.

During the first two years of the middle Yukon River sheefish study, fish were tagged at the Nowitna, Ray, Dall, and Porcupine rivers, Hess Creek, and at Rampart. Recoveries have for the most part been in the same location as tagged. In 1974, sheefish were tagged on the lower Yukon River as well as the middle Yukon River to learn whether fish passing through Rampart are from the lower Yukon River. The reader is referred to Alt (1972, 1973) for maps and preliminary data of the first two years of the tagging study.

Food habits data collected over the three years of the project are analyzed in this report. Spawning ground surveys in past years have located small groups of spawning sheefish in the upper Nowitna and upper Porcupine rivers. Spawning ground location of sheefish passing through Rampart in the fall has not been discovered. Research in 1973 failed to locate spawners in tributary streams and it was suspected that they spawned in the main Yukon River above Rampart. Work in 1974 centered in this area.

Age and growth studies have been completed for sheefish from all areas of the middle Yukon River and show little difference in growth between fish from Rampart and the Nowitna, Ray, and Dall rivers, and Hess Creek areas, but considerable differences in growth when compared to sheefish from the Porcupine River. Growth of lower Yukon River sheefish will be compared with that of sheefish from the middle Yukon River in this report.

TECHNIQUES USED

Sheefish for egg takes were captured in the Koyukuk River by hook and line and gill nets and in the Yukon River at Rampart using gill nets. Fish were kept in 2.5 x 1.2 x 1.2 m holding pens for ripening. Eggs were taken by the dry method. Eggs from Hughes were flown immediately to the Fire Lake Hatchery near Anchorage by charter aircraft, while eggs from Rampart were trucked to Fairbanks and sent to Anchorage by commercial airline.

Sheefish for the middle Yukon tagging study were collected with multifilament and monofilament gill nets of 5.0, 6.5, and 7.5 cm bar mesh, 25-32 m in length and 3.2 m deep. Fish were tagged with spaghetti tags and Floy internal anchor tags. A fishwheel was rented at Rampart to capture sheefish for tagging. Tag recoveries were made by subsistence and commercial fishermen and by the tagging crew.

Gill raker counts on sheefish from Marshall were made in the laboratory on the excised first left gill arch. Scales were mounted between glass slides and read with a Eberbach No. 2700 projector.

Radio transmitters installed in sheefish in the Yukon River were made by AVM Instrument Company, Champaign, Illinois. These transmitters, operating on a frequency of 50 MHz were developed for internal insertion in the body cavity, but five of these devices were attached externally with spaghetti tags.

Receivers mounted on an outboard powered riverboat utilizing a yagi antenna placed 6 m above the water level and in a slow flying aircraft utilizing a trailing coaxial antenna were used as tracking platforms.

Identification of food items eaten by middle Yukon River sheefish was made in the field. Results of stomach analysis are expressed as frequency and number of occurrences. In this analysis, each food item is given equal weight regardless of amount or size of the organism consumed. Percentage occurrence of each food item was obtained by dividing the number of stomachs containing a specific food item by the total number of stomachs containing food.

FINDINGS

R - II- A Sheefish Lake And River Adaptability Study

OBJECTIVES

1. To develop techniques for successful taking sheefish eggs.

2. To evaluate new methods of hatching sheefish eggs.

3. To find a method of rearing sheefish to fingerling size.

Egg Take

In 1974 special emphasis was placed on having trained hatchery personnel assist in the sheefish, Stenodus leucichthys, egg take at Hughes on the Koyukuk River. It was felt that failures of past years were due to improper handling of fertilized eggs and delay in getting them to the hatchery. The egg take crew at Hughes began holding sheefish on September 28. Koyukuk River water temperature was 4.0°C. Twelve males and 10 females were held for ripening in a 1.3 x 2.6 x 1.3 m holding pen until September 30. Water temperature was 2.5°C, but eggs were still not running freely. Since the plane had to leave on September 30, approximately four gallons or 480,000 sheefish eggs were taken on that date. Eggs had to be pressed out. They were flown directly to the hatchery after water hardening. Mortality was 100%, which hatchery personnel attributed to unripe eggs.

Sheefish were kept for ripening in holding pens at Rampart and 29 km above Rampart in the Yukon River from September 28 to October 4. Water temperatures in 1974 were 1°C to 2°C higher than in 1972 and 1973. From September 18 to September 24 the temperature was 9°C. By September 28 it had only gone down to 6°C and on October 1 it was 4°C. Beginning on October 2, considerably lower air temperature (-16°C) caused a rapid drop in water temperature to 1°C by October 4 at Rampart. On October 3 and 4 neither the 10 females in the holding pens nor the 3 females caught in the gill net were running eggs. However, since ice was running on the river and equipment was freezing up it was necessary to take eggs on October 4 and abandon the river. The eggs were not free in the ovary and much pressure had to be applied before eggs could be forced out. By the time the five quarts of eggs reached the hatchery 32 hours later all were dead.

It is apparent that eggs need to be running freely before they can be taken successfully. In 1975, spawners will be transported back to the Fairbanks area for ripening if necessary.

Past Sheefish Transplants

Lost Lake:

In February 1973 approximately 44,000 sheefish fry from the Fire Lake Hatchery were placed in Lost Lake. None were recaptured in 1973 and approximately 200,000 silver salmon, Oncorhynchus kisutch, were stocked to provide sport fishing. In May, 1974, 17 sheefish fingerlings were caught in a smolt trap along with 18,600 silver salmon at the outlet of Lost Lake. All of these were placed in Birch Lake. In July, fyke nets were set and a shocker boat unit was employed in an effort to capture sheefish. Only one 17 cm sheefish was captured along with 1,000 silver salmon.

Engineer Hill Lake:

No sheefish were caught in gill nets set in Engineer Hill Lake in 1973 and 1974, and it is assumed that all 44 of these fish stocked in 1971 have died.

Four Mile Lake:

A graduated mesh gill net set for two nights in Four Mile Lake on May 31, 1974 took 13 sheefish. Eleven were age VI (from the 1968 plant) and had a mean length of 589 mm (range 540-645 mm) and a mean weight of 2.27 kg (range 1.75-3.00 kg). Two fish were age V and had a mean length of 533 mm (range 523-542 mm) and weighed 2.25 kg. Two nets set overnight in December took eight fish. All were age VI and averaged 580 mm (range 535-610 mm and 2.42 kg (range 2.03-2.73 kg). Two of the four females taken appeared to have spawned this fall although a large portion of the eggs were reabsorbing. The other two females contained developing eggs and would have spawned in 1975. The four males had also spawned.

R - II - C Movements, Age and Growth, Spawning Ecology, Population Dynamics, and Utilization of Sheefish in the Middle Yukon River and Norton Sound Streams.

OBJECTIVES

1. To determine movements and population status of sheefish in the section of the Yukon River drainage from the mouth of the Koyukuk River upstream to Eagle.

2. To study the spawning ecology of sheefish in the middle Yukon River tributaries.

3. To compile data on age and growth, food habits, and population dynamics of middle Yukon River sheefish.

4. To determine sport and subsistence utilization of sheefish in Interior and Arctic streams.

5. To collect information on other species in conjunction with above objectives.

Movements

Tagging Study 1971-1974:

During the four year middle Yukon River study 1,890 sheefish were captured, although 265 of these were taken at Marshall in the lower Yukon River. Mean length of fish captured ranged from 508 mm in the Porcupine River to 745 mm at Rampart (Table 1). Only a selected sample of these fish were aged. The larger mean size of Rampart and Marshall fish is a result of capturing a higher percentage of mature fish. Approximately 96% of Rampart fish and 85% of Marshall fish were classed as mature, as opposed to only 65% of Hess Creek Fish.

Between 1971 and 1974, 1,257 sheefish were tagged on the Yukon River including 508 tagged in 1974. By December 31, 1974, 83 (6.7%) had been recovered. Figure 1 shows the number of fish tagged at the various locations, and locations of tag recoveries.

Table 1. Length-Weight Data For Sheefish Taken During Middle Yukon Study.

Location	Fork Length (mm) n	$\bar{x}$	Range	Weight (kg) n	$\bar{x}$	Range
Marshall	265	719	485-920	79	4.49	1.00-10.00
Nowitna River	627	705	170-930	361	3.93	1.00-11.00
Rampart	432	745	480-950	195	4.84	1.18-10.50
Hess Creek	203	646	265-900	153	3.45	0.25-7.75
Ray River	165	658	225-853	119	3.62	0.75-7.80
Dall River	56	716	535-870	44	4.06	1.50-6.75
Porcupine River	142	508	110-740	81	1.70	0.50-4.00
Total	1,890					

To determine if sheefish passing through Rampart were coming from the lower Yukon River, 187 sheefish were tagged at Marshall, 300 km from the mouth of the Yukon River, in early summer of 1974. Nineteen were recovered during the year. Eleven recoveries were in the same area as tagged, two were downstream from the tagging site, one was 200 km upstream from the tagging site, two were from the spawning grounds on the upper Koyukuk River, one was from the Yukon River 6 km upstream from Tanana, and two were from the Rampart area. Most recoveries of fish tagged in tributary rivers of the middle Yukon River were in the same area as tagged (Fig. 1).

Only four of the middle Yukon River tributary tagged fish had traveled upstream for distances greater than 100 km. Two fish tagged in the middle Porcupine River were recovered approximately 280 km upstream near Old Crow, Yukon Territory. Two of 31 recoveries of Nowitna River tagged fish were made farther upstream in the Yukon River, one below Tanana village and one at the mouth of Ray River. Five fish recovered downstream from the mouth of the Nowitna River may have moved downstream under tagging stress. Only one of 395 sheefish tagged at Rampart between 1972 and 1974 was recaptured. This is because a fishwheel was the main capture method used at Rampart and it was not until the end of the 1974 season that it was discovered that nearly all fish caught in the wheel died from shock soon after tagging.

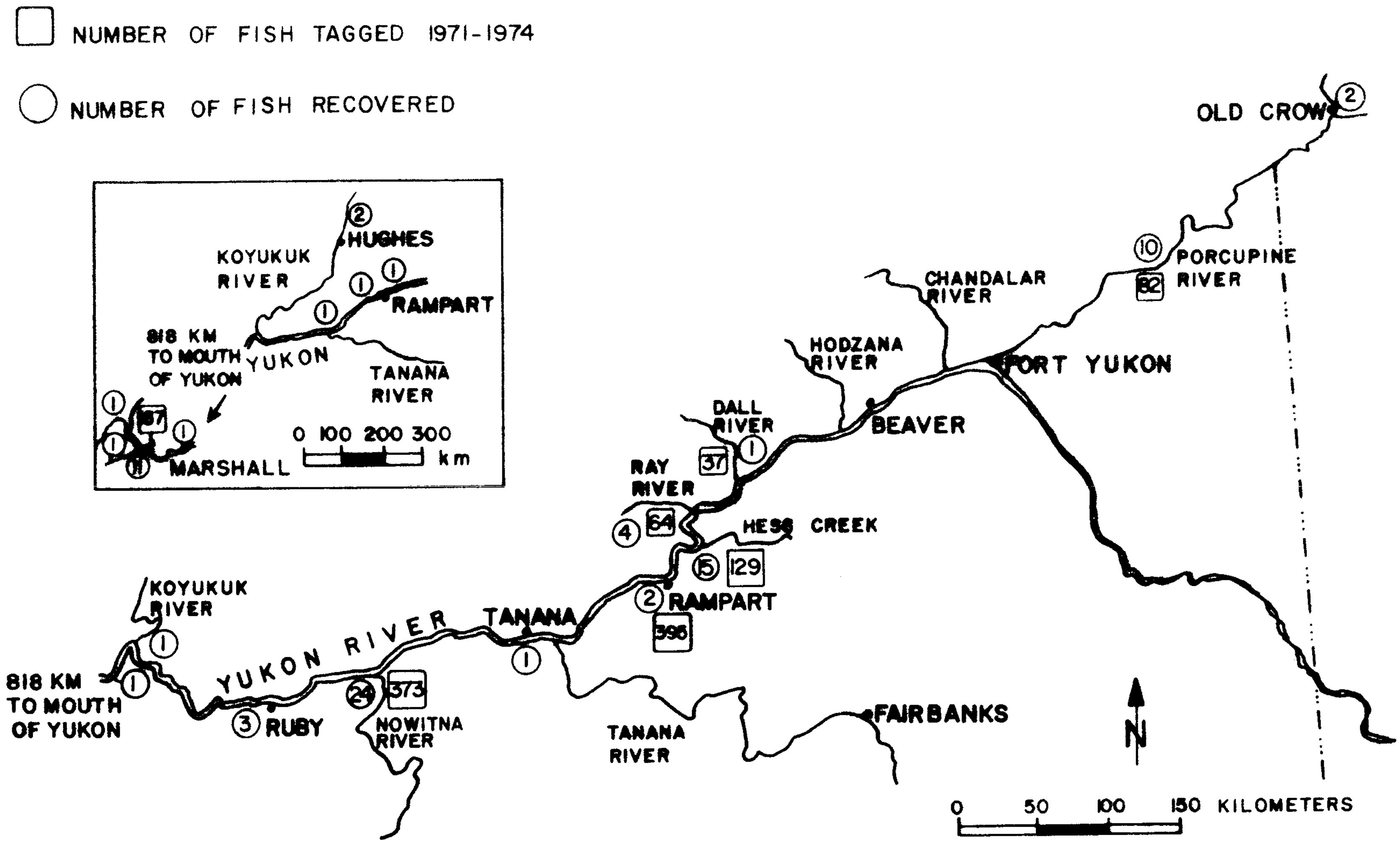

FIGURE 1. Sheefish Tag & Recovery Locations, Middle Yukon River, 1971-1974. See text for details. Inset shows tag & recovery data for Marshall (Lower Yukon River).

Population Status

Results of the tagging study, spawning surveys, and age and growth studies support a tentative hypothesis of two populations of sheefish in the middle Yukon River study area (mouth of Koyukuk River to Fort Yukon). The populations are:

1) The Lower Yukon population (named by Alt, 1973) consists of estuarine anadromous sheefish in the lower Yukon River, middle Yukon River, and Koyukuk River. The middle Yukon River (area above Rampart) and upper Koyukuk River are the main spawning grounds for this population. Sheefish found during the summer at mouths of tributary rivers of the middle Yukon River either belong to this population or are local sub-populations. Evidence supporting their inclusion into the lower Yukon population is: a) similar growth rates (Alt, 1973, 1974), b) similar taxonomic characters (Alt, 1974), c) recovery in spawning condition of two Nowitna River tagged fish upstream in the Yukon River near Tanana and the Ray River, and d) absence during the fall of fish tagged at mouths of tributary rivers in June. Evidence supporting a sub-population alternative is a) discovery of a distinct spawning group in the upper Nowitna River b) failure to recover in the lower Yukon River any fish tagged at the mouths of tributary rivers, and c) presence of sheefish at the mouths of the Nowitna, Ray, Dall rivers, and Hess Creek immediately after ice breakup, suggesting overwintering in the middle Yukon River.

2) The Porcupine River population consists of fish spawning, rearing, feeding, and overwintering in the Porcupine River in both Alaska and Canada. No tags of Porcupine River fish have been recovered in other systems, and conversely, no fish tagged in other systems have been recovered in the Porcupine. These fish grow slower than lower Yukon River sheefish and have a smaller maximum size (Alt, 1973).

Summary of Sheefish Movements

Based on tag return data and fishwheel and gill net catches, the following pattern of movements of middle Yukon River sheefish is discerned.

Sheefish overwintering in the lower Yukon River begin migrating upstream during breakup. The spawning fish begin passing through Rampart in August, with the peak of the run usually in early September. After spawning farther up the Yukon River (possibly near Beaver in the Yukon Flats) in mid-October, the fish migrate downstream to the lower Yukon River, reaching the area near Marshall and Emmonak in November. Sheefish found at the mouths of the Nowitna, Ray, Dall rivers, and Hess Creek immediately after breakup overwinter in the main Yukon River near mouths of these streams. After spring ice breakup these fish, consisting of both mature and immature fish, move into the lower reaches of the tributary rivers for feeding. Feeding sheefish have been taken 115 km up the Nowitna River, but only 3 km up Hess Creek and

Ray River. Sheefish abundance at mouths of tributary rivers decreases with time, and by early October sheefish are absent from these areas. The spawning portion of these fish evidently leave the tributary river mouths and travel up the Yukon River to spawn. Some of the Nowitna River fish spawn in the upper Nowitna River (Alt, 1974). Non-spawning sheefish of the middle Yukon River tributaries disperse to the main Yukon during the fall. Tag recoveries indicate that these sheefish home back to the same stream mouth year after year. Their winter movement is not documented as there is no winter fishing effort.

Spawning

In 1974 the search for spawning grounds of sheefish passing through Rampart in the fall was concentrated in the main Yukon River above Rampart. Data on run timing of spawning were collected by test netting and fishwheel. Radio transmitters were installed to assist in following migrating spawners.

Rampart Test Netting:

Gill nets were set in various areas near Rampart in September, 1974 in an attempt to find concentrations of spawning fish. A gill net was set in an eddy of the Yukon River at Rampart village for 19 days and took 50 sheefish (80% mature) (Table 2). Data on other associated species collected is also presented in Table 2.

The most successful gill net location was 9.6 km below Hess Creek. Ninety-four (6.7 per net night) fish were taken at this site from September 19 to October 14. During the first day of fishing at this site on September 19, 16 sheefish were taken. Very few sheefish were taken in other gill net sets in the Rampart area. Few sheefish were captured in gill nets set in the inshore, dead water areas of eddies. The capture of most fish at the swift edge of the eddies suggested an upstream migration rather than a pre-spawning concentration, which would normally be in a quiet eddy. Most fish were caught 1-1.2 m below the surface. Water depth at the offshore end of this gill net was 8 m. Eighty-nine percent of the total gill net catch below Hess Creek consisted of mature sheefish.

Rampart Fishwheel:

In 1974 the Rampart fishwheel was in operation from September 3-29. Only 94 sheefish were caught, compared with 160 caught in 1972 and 161 in 1973. Fishwheel operation began one week later in 1974 and the largest catches were made on September 3 and 4. Delay in starting the wheel plus difficulties encountered with very low water levels may have been responsible for the lower catch. All fish taken by fishwheel were spawners.

Peak upstream migration dates as determined by fishwheel catches during the three years of the study were September 12-15, 1972; August 25 to September 1 and September 12-14, 1973; and September 3-4, 1974. During 1972, the wheel was not operating until September 1.

Table 2. Rampart Area Fall Fishing Results, 1974.

Area	Dates	Net Nights	RS**	SS	CS	SF	HWF	BWF	NP
9 km above Rampart	Sept. 12-16	5		1	26	1	13	13	5
4 km below Rampart	Sept. 13-16	4		2	6	1	4	11	2
Rampart	Sept. 17 to Oct. 4	19	1	39	131	50	205	253	2
Fishwheel*	Sept. 3-29		1	3	872	94	16	9	
18 Mi. Site (above Rampart)	Sept. 25 to Oct. 4	14		114	155	94	60	109	
Hess Cr. Mouth	Sept. 19-20 Oct. 1	2 1				2 2	1	1	3
3 km above Hess Creek	Sept. 19-20 Oct. 1	3 1		3 5	33 2	7	9 2	5	4
2 km below Ray River	Sept. 21-23	5		1	64	1	28	36	1
Ray River Mouth	Sept. 21-23	3			12	8	1	10	9
Total			2	168	1,301	260	339	447	26

*Also caught 17 BCI, 7 LCI

**RS - Red Salmon, *Oncorhynchus nerka*
SS - Silver salmon, *O. kisutch*
NP - Northern pike, *Esox lucius*
BWF - Broad whitefish, *C. nasus*
BCI - Bering cisco, *C. laurettae*
CS - Chum salmon, *O. keta*
SF - Sheefish, *Stenodus leucichthys*
LCI - Least cisco, *Coregonus sardinella*
HWF - Humpback whitefish, *C. pidschian*

During the past two years of the study, it was assumed that the upstream migration had passed Rampart by September 28, as fishwheel catches averaged one or less sheefish per day. In 1974, the fishwheel showed a similar pattern but a gill net set in the large eddy 29 km above Rampart took 54 mature sheefish from September 28 to October 4 (7 net nights) including 4 sheefish the last day of the study on October 4 when water temperature was 1°C. Apparently the upstream migration is quite protracted.

Middle Yukon River Transmitter Tagging Experiment:

Ten sheefish were fitted with radio tags and released into the Yukon River between September 12 and September 29, 1974. The fish tagged were all spawners (8 males, 2 females) and ranged in length from 63 to 83 cm. The first five fish were caught in a fishwheel at Rampart, tagged internally, retained in a holding pen for 24 hours or less, then released. The fish were followed by boat after release, and in all cases the fish moved downstream immediately after reaching the swift current of the Yukon River. When using the boat for tracking, the radio signal could be picked up for a maximum distance of approximately 300 m. Contact with all fish was lost within one hour and subsequent searches 50 km both upstream and downstream by boat and airplane failed to pick up signals from four of the five fish. The only fish located was 6 km downstream from Rampart 16 hours after release. The fish was in the same location for the next five days in swift water of 1-1.5 m depth and it was concluded that the fish was dead. I feel that all fish that had been captured in the fishwheel then radio tagged were so weak that they drifted downstream and died. Death was probably caused by shock from three sources: a) fishwheel, b) tagging, and c) handling of any sort. To test if the fishwheel was the main cause of shock, three fish caught in the fishwheel were held for three to six days then released with only a small plastic float, attached by 3 m of monofilament line. All three fish began drifting downstream at a speed nearly as fast as the current. The fish were weakly swimming both laterally and upstream, but did not seem to have the strength to swim against the swift current. It was assumed that these fish all died.

The next five fish were removed from a gill net at 29 km above Rampart between September 27 and 29 shortly after being caught, fitted with radio tags, and then held in a pen for two to four days before release. The transmitters were placed externally behind the dorsal fin and secured with spaghetti tags. These fish were in better condition when released than the earlier group. The general pattern of behavior for these five fish was similar. After resting for 5 to 40 minutes in the large eddy where released, the fish swam out into the swift current (8-10 km/hr.) in the center of the Yukon and slowly lost ground. Contact was lost with all fish after 20 to 90 minutes. Release of three other fish with only balloons attached confirmed that the fish swam back and forth and occasionally upstream in the swift current but lost ground downstream. One passed through Rampart, 29 km downstream, seven hours after release. The others eventually made it into slack water on the opposite side of the Yukon River 2 km below the release site. Two of the five transmitter tagged fish were located by airplane the day after release. The fish released on September 27 was 3.5 km below the release site on the opposite side of the river. The fish released on October 1 was located 2.0 km below the release site on the opposite side of the river but contact was then lost. The September 27 tagged fish was tracked by boat through October 2. On September 28 the fish had moved upstream 150 m and was in slack water about 15 m from shore in water 1.5 m deep. On September 30 at 11 a.m. the fish had moved upstream 6.7 km (3.2 km above the release site). By 5 p.m. the fish had traveled an additional 2.4 km upstream on the same side of the river (current speed 8-10 km/hr). Two days later it was 42 km upstream from its last sighting and on the same side of the river. Two days later I followed the course of the Yukon River 9 km beyond the point of last sighting to the Yukon haul road but did not locate the fish. I believe it had migrated upstream past the haul road by this time. From September 30 to October 2 this fish had migrated upstream 50 km in 44 hours.

The radio tagging operation could be termed a limited success. One fish was successfully tracked upstream for a least 50 km, and coupled with other supporting data, did offer evidence that sheefish spawn above the Yukon River bridge located 3 km upstream of Ray River mouth of the Yukon River. The Yukon River is simply too big for effective radio tracking, and when dealing with sheefish which may migrate over 1,800 km upstream, it is a major project to follow them. Radio tagging would be much more feasible on smaller streams and lakes. An airplane was a better tracking vehicle than a boat as a greater area could be covered. The area of the Yukon River where the tagged fish were travelling was only 0.8 km wide, but in the Yukon Flats, where the river is up to 4 km wide, as many as four passes would have to be made with an airplane to pick up the signals. I was able to receive signals from the air up to 1 km in distance. The optimum altitude was 200 m.

It might be advantageous to have the tag designed so as to be more hydrodynamic for external attachment. Fish should be handled as little as possible to reduce shock. In spite of the advantages of being able to follow individual fish by having each transmitter on a separate frequency, it would be preferable in some studies to have all transmitters on the same frequency.

Discussion of Middle Yukon River Spawning

No sheefish spawning grounds were located during 1974. The hypothesis that sheefish do not spawn in Hess Creek, Ray or Dall rivers was reinforced by 1974 test netting. Two factors, extreme shallowness of these rivers in late September and absence of spawners from gill net catches supported this. A gill net set across Hess Creek on October 1 took no mature sheefish, whitefish, or salmon, even though large numbers of all species were being taken at 10 km below Hess Creek.

I believe the majority of the sheefish passing through Rampart spawn above the Yukon River bridge (3 km above Ray River), possibly in the Yukon Flats between Dall River and Fort Yukon. Spawning sites are restricted by potential for freezing. The water level of the Yukon River normally drops 2-3 m from October to April, and fish would have to spawn in water deeper than 5 m to prevent the eggs from freezing. In other streams in Alaska spawning can take place in water 2 m deep.

Spawning period of these fish, at least in 1974, would be later than October 4. Sheefish eggs were not running freely on that date when I left the Yukon River, indicating that spawning was at least a week away. This would be later than spawning dates for other Alaska sheefish. Koyukuk River sheefish spawn the last days of September and the first days of October (Alt, 1968), Kuskokwim River sheefish spawn the first days of October (Alt, 1972), and Kobuk River sheefish spawn the last week of September.

Since sheefish passing through Rampart in late September would probably not spawn until mid-October, they would have sufficient time to migrate up to the Yukon Flats between Dall River and Fort Yukon or possibly the Chandalar River, the only areas not extensively surveyed for spawning fish. It appears likely, however, that they spawn in the main Yukon River rather than in the Chandalar River because lower water temperatures and earlier dates of freezeup in the tributaries would necessitate spawning earlier than mid-October. The Chandalar River is completely above the Arctic Circle. Low levels of effort are expended for subsistence and sport fishing in the section of the Yukon Flats from Stevens Village to the mouths of the Chandalar River, making it difficult to pinpoint large concentrations of sheefish. The Rampart sheefish evidently do not enter the Porcupine River to spawn, as extensive gill netting in late September 1973 failed to take any sheefish spawners in the lower 230 km of the Porcupine River (Alt, 1974).

A small number of sheefish spawn in the upper Nowitna River in the vicinity of the Sulukna River, 290 km up the Nowitna (Alt, 1974). These fish have growth patterns similar to fish of the lower Yukon River population and could be considered as part of that population.

The slower-growing Porcupine River population spawns in the upper Porcupine River in Alaska and Canada. Sheefish in spawning condition were captured 240 km up the Porcupine River in 1973 (Alt, 1974) and young-of-the-year sheefish have been captured at various locations in the Porcupine River during all years of the study. Indirect proof of Canadian spawning of this population is offered by Bryan (1973) who reports finding young-of-the-year sheefish over 500 km up the Porcupine.

Taxonomic Data

Gill raker counts were made on 21 sheefish taken in the Yukon River at Marshall. The tag and recovery program indicated that the Marshall fish are the same fish passing through Rampart in the fall and the same fish spawning in the upper Koyukuk River in September. The mean total count for Marshall fish of 20.7 gill rakers and range of 20-25 gill rakers are in close agreement with counts of sheefish from the Nowitna, Ray and Porcupine rivers and Hess Creek (Alt, 1973). Mean lower limb counts of Marshall fish were 6.0 gill rakers and upper limb counts were 13.7 gill rakers.

Summary of Middle Yukon River Age and Growth

Age and growth studies on sheefish of various areas of the middle Yukon River indicate that, with the exception of Porcupine River sheefish, growth of sheefish found at the mouths of tributary streams of the Yukon, as well as fish of the Koyukuk River and main Yukon River is similar (Alt, 1972; Alt, 1973). A least squares fit of fork length vs. age at capture for sheefish from Nowitna River, Hess Creek, Ray River, and Dall River indicated no apparent growth differences.

Scales were read from a selected sample of sheefish from Marshall and, as expected, their growth curve is similar to that of Rampart sheefish. Growth of Marshall fish was compared with growth of the combined Nowitna, Ray, Dall rivers, and Hess Creek sample and there was no significant difference in the slopes of the lines at the .05 level.

Summer Food Habits of Middle Yukon River Sheefish

Stomachs of 333 sheefish from middle Yukon River tributaries were examined to determine major food items eaten during late May to September. Stomachs were collected between 1971-1974 from fish not tagged. Data were combined for all years because of the small sample for each year and because stomach contents were similar for each year. Sheefish were collected from the same area each year. With the exception of a few stomachs from the Nowitna and Porcupine rivers collected in mid-September, all food habits data are from fish taken in late May and June. Because of the small sample, close geographic location, and similarity of food items eaten, all sheefish taken at the mouths of Hess Creek, Ray and Dall rivers and locations in the main Yukon River near these rivers were combined for purposes of stomach analysis.

Lampreys, *Lampetra japonica*, Humpback whitefish, *Coregonus pidschian*, and least cisco, *C. sardinella* were the food items most frequently eaten by middle Yukon River sheefish (Table 3). Suckers, *Catostomus catostomus*, were next in frequency. Lampreys were more important in the diet of sheefish from Ray and Dall rivers and Hess Creek than from other areas. Lampreys might be more available in early and mid-June when these sheefish were taken, as the Nowitna fish were all taken in late May and early June.

Most whitefish found in sheefish stomachs were partially decomposed so the prey species could often be identified only to genus. The whitefish that could be identified to species were mainly least cisco and humpback whitefish of age classes I and II. Even though adult broad whitefish, *C. nasus*, were very abundant at all locations, very few young broad whitefish were found in stomach samples or gill net catches. In all areas least cisco were more frequent in the diet than humpback whitefish by a ratio of about 3 to 2. Species composition catches from graduated mesh gill nets (five panels of from 1/2" - 2 1/2" bar mesh) substantiated this. With the exception of lampreys, which were about 16 cm in length, sheefish seldom ate prey species over 15 cm in length or older than two years. Suckers are present in all streams studied, but were used more as a food item by Nowitna River sheefish. Northern pike are abundant in all areas studied and spawn in the vicinity where sheefish were captured but were very seldom eaten. The only recorded incidence of cannibalism was a sheefish taken in the lower Nowitna River in September that had eaten 14 other sheefish (up to 14 cm in length). Sheefish of age 0 and I were present in the Porcupine River but were not eaten by other sheefish. Salmon fry and fingerlings were important items in diets of upper Yukon River sheefish (Alt, 1965; Walker et al, 1974) and Holitna River sheefish (Alt, 1972), but were seldom found in stomachs of middle Yukon River sheefish. Insects were important only in the diet of Porcupine River sheefish. Mosquito pupae and mayfly nymphs were most common, but dragonfly larvae, true bugs and water beetles were taken.

The food habits study confirms that sheefish are opportunistic feeders and generally feed on fish species most available to them. Food items are generally small, with most fish prey species being 10-15 cm in length.

Fish that would spawn in the fall of 1974 were feeding in June, but nearly all spawning fish examined in August and September had empty stomachs. The first recorded incidence of spawning fish feeding was recorded on September 27, 1973 when stomachs of three spawning sheefish in the upper Porcupine River were found to have remains of Coregonus sp. in their stomachs.

Utilization and Conservation

The major use of sheefish in the middle Yukon River is subsistence. The mature sheefish migrating up the Yukon past Rampart in August and September make up most of the catch. They are caught incidentally during the fall subsistence and commercial fishery for chum, Oncorhynchus keta, and silver salmon. After the close of the commercial fishery for salmon, residents of villages along the river set nets specifically for whitefish and sheefish to be used for both human consumption and dog food. With increased cost of dog food, dog mushers from Fairbanks are subsistence fishing for their dogs in the middle Yukon River.

Exact figures for the sheefish subsistence catch are not available for the entire middle Yukon River. Over 500 were taken for subsistence by fishermen located in the Rampart Canyon and at Rampart during August and September, 1974. They report taking very few during the king salmon, O. tshawytscha, and summer chum salmon commercial fishery. If the villages of Ruby, Tanana, Stevens Village, and Beaver were considered, the total subsistence catch would be over 1,000 fish averaging 6.3 kg and 815 mm for males and 3.6 kg and 730 mm for females. The subsistence effort and catch in June and July is quite small.

Sheefish are important sport fish in the clearwater tributaries of the middle Yukon River and will probably become more important with increased road access. The important sport fishing streams are the Nowitna, Melozitna, Ray, Dall, and Porcupine rivers and Hess Creek. Probably less than 500 are taken per year. The average sport-caught sheefish in these streams is smaller than fish passing through Rampart because many immature fish are caught by sportsmen.

Table 4. Summer Stomach Contents of Sheefish from Various Areas of the Middle Yukon River 1971-1974. Twenty-Three of 126 Nowitna River Stomachs; 26 of 124 Hess Creek, Ray and Dall Rivers Stomachs; and 28 of 83 Porcupine River Stomachs were Empty.

Food Organism	Nowitna R. 103 Sheefish			Hess Cr., Ray & Dall R., Rampart 98 Sheefish			Porcupine R. 55 Sheefish		
	Number of Organisms	Stomachs in which Item Occurred		Number of Organisms	Stomachs in which Item Occurred		Number of Organisms	Stomachs in which Item Occurred	
		Number	Percent		Number	Percent		Number	Percent
Lamprey	132	39	38	178	61	62	63	23	42
Coregonids:									
RWF	1	1	1	...	...	...	1	1	2
HWF	7	3	3	2	2	2	3	3	5
BWF	...	...	...	1	1	1	...	...	...
LCI	70	15	14	3	3	3	2	2	4
Fish Remains*	322	74	72	102	48	49	42	26	47
Sucker	135	38	37	22	10	10	19	8	14
Burbot	6	6	6	2	2	2	2	2	4
Chubs	...	...	...	...	...	...	3	3	5
Sheefish	14	1	1	...	...	...	...	...	...
Pike	...	...	...	8	4	4	1	1	2
Salmon	...	...	...	1	1	1	...	...	...
Sculpin	...	...	...	3	1	1	...	...	...
Insects	2	2	2	...	...	...	55	5	11

*All Coregonus sp.

Lamprey= Lampetra japonica
BWF=Broad whitefish, C. nasus
RWF=Round whitefish, C. cylindraceum
Burbot=Lota lota
Sheefish=Stenodus leucichthys
Salmon=Onchorynchus sp.

HWF=Humpback whitefish, Coregonus pidschian
LCI=Least cisco, C. sardinella
Sucker=Catostomus catostomus
Chub=Couesius plumbeus
Pike=Esox lucius
Slimy sculpin=Cottus cognatus.

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